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ABSTRACT

Ten activities that feature a hands-on, student inquiry-based investigatory approach to rocks and minerals are presented. "Guided discovery" and/or inquiry instructional strategies are emphasized. They focus on a student-centered active classroom. Each activity includes the heading, science content, the scientific process skills, objective or purpose, the lesson outline (time, minerals, preparation, procedure), and worksheets to be handed out to students. Mineral identification, classification, and characteristics of minerals and rocks (streak and hardness) are the subjects of the activities. (KR)

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Building New Partnerships - Museums, Universities, and Schools:

A "Rocks and Minerals" Thematic Loan Kit

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Building New Partnerships - Museums, Universities, and Schools:

A "Rocks and Minerals" Thematic Loan Kit

Have you ever borrowed education materials for your classroom from a museum or other science education center? Have the materials been worth the effort it takes to make special arrangements? How can you help to improve the materials? This paper presents some ways to help organize and improve resource materials and contains earth science activities for elementary, middle, and junior high school students.

Many museums have opened up their doors to students and teachers to enjoy the wonders of science and technology.¹ Museums house a fabulous array of hands-on collections, the stuff needed to teach science. Several museums and school districts across the United States, including The Carnegie Museum of Natural History in Pittsburgh, Pennsylvania have established loan collections for distribution to teachers of elementary, middle, and junior high schools.² Thematic Loan Kits including those exploring native North American Indian cultures, dinosaurs, and animal tracks have been favorites of dozens of teachers since 1980 in the Pittsburgh area. These kits contain touchable specimens or artifacts, related audio-visual materials such as photographic slides or cassette tapes, and printed materials such as manuals, student guides, and books. The materials are packed neatly into a hard wood box. All of the items in the kits are important ingredients to teachers who have experienced scarce

resources, limited time, and tight budgets. Traditionally, however, many teachers in their evaluations of museum loan kits have cited the need for more information and direction concerning how to best use the materials and how to structure hands-on, minds-on activities related to the kit's wares.

Teamwork Is The Key To Success

A recent effort by teachers, museum staff, and university faculty of the Pittsburgh area highlights the benefits of teamwork while putting more structure and pizzazz into the Thematic Loan Kits. Staff members of the museum contributing to the project included scientists, natural historians, display artisans, and education specialists. These experts and their predecessors have been successful in collecting, organizing, describing, and distributing educational materials to teachers since the end of the 19th Century at The Carnegie Museum of Natural History. Experienced master teachers currently in the schools know about the types of activities that motivate and help children to understand science concepts. They know not only which activities to plan , but how to put the lessons together in a concise and meaningful way. University faculty of the School of Education have expertise in curriculum development and planning. They provide insights into balancing instruction theory and practice.

A task force of six individuals representing the three institutions worked together on the project. Several planning meetings were held for discussion of goals, design, timetable,

and work assignments. Once the framework for the kit was established, update and evaluative sessions confirmed the progress of the project. Within the collaborative, university faculty served the function of liaison between museum specialists and teachers. Comradeship and cooperation were keys to successful results of the project.

New Product

The first prototype thematic loan kit to be assembled and tried out entitled "Rocks and Minerals" contains traditional materials--labeled assorted rocks and minerals, a descriptive guide to North American rocks and minerals, resource booklets, and related photographic slides. In addition, as a product of the collaborative, several lessons complete with listing of objectives, suggested procedures for teachers and students, student worksheets and other handouts, supplemental activities, bibliography and special equipment with instructions are included in the kit. The equipment and supplies include: streak plates and hardness testing kits, magnifying glasses, and most importantly multiple samples of 12 different rocks and minerals. The new package of materials, much more extensive in scope than the traditional kit, fit in several hard wood box containers, convenient for transport and storage purposes.

Results

Teachers have been delighted with the new "Rocks and Minerals" kit. The kit has introduced new teaching strategies while providing a more conceptual understanding of science.

Students are enjoying the hands-on activities. Investigations of rock and mineral characteristics with such "catchy" titles as "By the Light of the Silvery Mica", "Don't Take a Powder Now", and "Color by Number" are providing students new insights into the essence of doing science. Teachers are contributing modifications, new ideas and other activities for inclusion in the kit. With such overwhelming positive feedback, plans are on the drawing board for other thematic loan kits with topics concerning: botany, Pittsburgh area geology, and insects and other invertebrates. Sharing the workload and expertise in developing the kit has brought shared rewards by all; teachers, museum staff, and university faculty.

Selected Activities "Rocks and Minerals"

The following have been tried and evaluated as successful activities by dozens of teachers in elementary, middle, and junior high schools. Teachers, who do not have access to museum loan kits or similar packages, can find many of the materials locally at low cost. Other materials can be borrowed from senior high schools or purchased from education/scientific suppliers, including rocks and minerals collections. The activities, recommended grade levels, and corresponding page numbers, include:

Mineral Identification (Grades 3-8)	p. 7
Color by Number	p. 8
Look At Those Lines	p. 9
By the Light of the Silvery Mica	p. 10

Color Me Anything (Grades 3-8)	pp. 11-14
Don't Take a Powder Now (Grades 3-9)	pp. 15-17
Classifying Rocks According to Hardness (Grades 6-9)	pp. 18-19
Investigation 1	pp. 20-21
Investigation 2	p. 22
Investigation 3	p. 23
Identifying Common Minerals (Grades 7-9)	pp. 24-30
Rock and Mineral Classification (Grades 6-9)	pp. 31-32

Organizational Components of the Activities

Activities are presented in the following format:

Heading (Title)

Science Content

Process (Scientific Process Skills)

Objective or Purpose

Lesson Outline (Time, Minerals, Preparation, Procedure)

Handouts (Student Worksheets)

Recommended Instructional Strategies

The activities feature hands-on, student inquiry-based investigatory approaches. The authors intend the teacher to emphasize "guided discovery" and/or inquiry instructional strategies which focus on a student-centered active classroom.³

References

1. Cole, Peggy Ruth. (1989). The Schooling of Museums.
Science Scope 12(5), February, 6-9.
2. Bedworth, Jacalyn (Ed.) (1985). Science Teacher Education
at Museums: A Resource Guide, Washington, D.C.:
Association of Science-Technology Centers.
3. Carin, Arthur, & Sund, Robert B. (1989). Teaching Science
Through Discovery, 6th Ed., Columbus, OH: Merrill
Publishing Company.

MINERAL IDENTIFICATION

Color By Number/Look At These Lines/By The Light Of The Silvery Mica

Science Content: mineral characteristics

Process: observation, inference, recording data

Objective: The student will identify characteristics of minerals including color, shape, and luster.

Lesson outline:

Time: approx. 20 minutes per activity

Materials: quartz, graphite, talc, biotite, halite, muscovite

Preparation: Before class sort out the various minerals making sure each group of 2 students will have 1 piece (approx. 1 1/2 inch diameter) of each mineral.

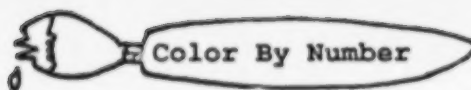
Procedure:

1. Discuss characteristics of minerals.

Lead question: What are some of the ways you can identify rocks and minerals?

2. Break students into small groups (recommended 2 students per group).
3. Have students do activities.
4. After the completion of the three activities, discuss findings. Tie each of the activities together, checking for students understanding with questioning. Questions might include: What characteristics can we use to identify minerals? What are disadvantages to using only color (or only shape/luster) characteristics to identify minerals?

Handouts: Student Worksheets



Name _____
Date _____
Class _____

Purpose: To discover several ways to identify minerals.

Materials: quartz calcite biotite graphite
 talc halite muscovite

Procedure:

1) Look at the quartz. Describe its color. _____

2) Look at the graphite. Describe its color. _____

3) Compare the colors of the two minerals. How are they alike?

How are they different? _____

4) What physical properties of minerals were you describing? _____

5) What is one way to identify quartz? _____

6) What is one way to identify graphite? _____

7) What is one way to identify a mineral? _____

8) Name one physical property of minerals. _____

Name _____
Date _____
Class _____

Part II



Purpose: To discover ways to identify minerals.

Materials: quartz calcite biotite graphite
 talc halite muscovite

Procedure:

- 1) Look at the halite. Describe its shape. _____
- 2) Draw the halite.
- 3) Look at the calcite. Describe its shape. _____
- 4) Draw the calcite.
- 5) How are the minerals alike? _____
- 6) How are they different? _____
- 7) What physical property of minerals were you looking at?
- 8) What is one way to identify halite? _____
- 9) What is one way to identify calcite? _____
- 10) Besides color, what is another way to identify a mineral?

- 11) What is another physical property of minerals?

By the Light of the Silvery Mica



Name _____
Date _____
Class _____

Part III

Purpose: To discover several ways to identify minerals.

Materials: quartz calcite biotite graphite
 talc halite muscovite

Procedure:

- 1) Look at the talc. Is it shiny or dull? _____
- 2) Look at the muscovite (silver mica). Is it shiny or dull? _____
- 3) Look at the biotite (black mica). Is it shiny or dull? _____

Geologists have a special name for how shiny or dull a mineral is. They call it luster. Shiny and dull are two examples of different lusters.

- 4) What physical property of minerals were you looking at? _____
- 5) What are color, shape, and luster examples of in minerals? _____
- 6) What do all minerals have? _____

COLOR ME ANYTHING

Science Content: characteristics of minerals and rocks

Process: observation, classifying/sorting, inference, recording data

Objective: The student via studying comparisons of minerals and rocks will formulate the concept that rocks are made of minerals.

Lesson outline:

Time: approximately 60 minutes

Materials: Assorted rock and mineral samples labelled with an ID number, as for example:

- | | |
|------------|-------------|
| 1. granite | 3. mica |
| 2. quartz | 4. feldspar |
- and magnifying glasses.

Preparation: Before class sort out the various rocks and minerals making sure each group of 2 students will have 1 piece of each rock and mineral.

Procedure:

1. Discuss characteristics of rocks and minerals (perhaps via a mini-review of MINERAL IDENTIFICATION ACTIVITIES completed previously).

Lead question: What are rocks made of? It is important not to draw any conclusions at this point in time.

2. Break students into small groups (recommended 2 students per group) or have students work alone.
3. Have students do the activity. While students do the activity circulate around the room checking students progress.
4. After the completion of the activity, discuss findings. Tie each aspect of the activity together, checking for students understanding with questioning.

Handouts: Student Worksheets

Color Me Anything

Name _____
Date _____
Class _____

Purpose: To formulate the concept that rocks are made of minerals.

Materials: Assorted rock and mineral samples

- | | |
|------------------|-------------|
| 1. granite | 3. mica |
| 2. quartz | 4. feldspar |
| magnifying glass | |

Procedure:

- 1) Examine the granite carefully.
- *2) What colors do you see?
- 3) Examine the quartz carefully.
- *4) What color is quartz?
- *5) Is the quartz rough or smooth?
- *6) Is the quartz shiny or dull?
- 7) Use your magnifying glass. Carefully examine your piece of granite again.
- 8) Find some white, smooth, shiny material on the granite. Compare this material to your piece of quartz.
- *9) What do you think this material is?
- *10) How do you know?

Color Me Anything

- *11) Name one material found in granite.
- 12) Examine the mica carefully.
- *13) What color is the mica?
- *14) Is the mica rough or smooth?
- *15) Is the mica shiny or dull?
- 16) Use your magnifying glass. Carefully examine your piece of granite. Find some block material on your granite. Compare this material to your piece of mica.
- *17) What do you think this material is?
- *18) How do you know?
- *19) Name another material found in granite?
- 20) Examine the feldspar carefully.
- *21) What color is feldspar?
- *22) Is speldspar rough or smooth?
- *23) Is feldspar shiny or dull?
- 24) Use your magnifying glass. Carefully examine your piece of granite. Find some pink material on your granite. Compare this material to your piece of feldspar.
- *25) What do you think this material is?
- *26) How do you know?

- *27) Name another material found in granite.
- *28) Name three materials found in granite.
- 29) Make a drawing of your piece of granite. Label the quartz, mica and feldspar.
- *30) What is granite?
- *31) What minerals does granite contain?
- *32) What are quartz, mica and feldspar examples of?
- *33) In one word, what is granite made of?
- *34) In one word, what would you predict rocks are made of?

DON'T TAKE A POWDER NOW

Science Content: mineral characteristics

Process: observation, classifying/sorting, inference, recording data

Objective: The students will identify the streak of various minerals.

Lesson outline:

Time: approximately 60 minutes

Materials: assorted minerals, streak plate

Preparation: Before class sort out the various minerals making sure each group of 2 students will have 1 piece of each mineral.

Procedure:

1. Discuss characteristics of minerals.
2. Break students into small groups (recommended 2 students per group).
3. Demonstrate to the students the method of using the streak plate. Emphasize that the students should wipe the plate clean after each use (but, do not state the reasons for this).
4. Demonstrate to the students how to use the data table, showing where the record of each observation goes.
5. Have students do the activity. While students do the activity circulate around the room checking students progress.
6. After the completion of the activity, discuss findings. Check for students understanding with questioning.

Handouts: Student Worksheets

Don't Take a Powder Now

Name _____
Date _____
Class _____

Purpose: To discover the streak of various minerals.

Materials: assorted minerals, streak plate

Procedure:

- 1) Using a streak plate, complete the table below. Make sure that you wipe the streak plate off after each use.

Mineral	Color	Streak
Calcite		
Sulfur		
Feldspar		
Halite		
Graphite		
Chalcopyrite		
Magnetite		
Hematite		
Galena		

Don't Take a Powder

FINISH



Questions:

- 1) What physical property of minerals were you investigating?
- 2) Name 4 physical properties that can be used to identify minerals.
- 3) Why should a streak plate be wiped clean after each use?
- 4) Would it be a good idea to use a streak plate of red or brown tile? Explain your answer.
- 5) Would using a streak test be a good way of identifying rocks? Explain.

CLASSIFYING ROCKS ACCORDING TO HARDNESS

Investigations 1, 2, and 3

Science Content: Characteristics of minerals; Mohs Scale of Hardness

Process: observation, classification, inference, recording data, interpreting data

Objective: The student will identify the hardness of various minerals and rocks using the Mohs Scale of Hardness.

Lesson outline:

Time: approx. 20-30 minutes for the Introduction, and
approx. 20-30 minutes per investigation

Materials: assorted rocks and minerals, pieces of chalk, steel knives, pieces of glass

Preparation: Before class sort out the various rocks and minerals making sure each group of 2 students will have 1 piece of each rock and mineral.

Procedure:

1. Introduction - Discuss characteristics of rocks and minerals.
2. Handout Student Worksheet Page 19 (Background information). Let the students read this sheet.
3. Discuss the Mohs Scale of Hardness.
4. Investigation - Mention safety precautions concerning use of knives and glass. Have students complete Investigation 1. Make sure students are using proper techniques, demonstrate proper techniques where necessary.
5. Demonstrate to the students how to use the data table, showing where the record of each observation goes. Check for understanding of the concept by questioning.
6. Allow the students to proceed through Investigations 2 and 3.
7. After the completion of the three investigations, discuss findings. Tie each of the investigations together, checking for students understanding with questioning.

Handouts: Student Worksheets

Classifying Rocks According to Hardness

Background Information:

When someone has a sample of a rock or a mineral and is trying to decide what kind it is, the hardness of the rock or mineral is an important clue.

To find out the hardness of a mineral, you test it by scraping the mineral with other substances and by using the mineral to scrape other substances. Substances that are harder than the mineral you are testing will leave a scratch mark on it. The mineral will leave a scratch mark on substances that are softer than it is.

The German Mineralogist, Friedrich Mohs (1773-1839), tested the minerals in his collection and observed the differences in their hardness. By comparing the hardness of one mineral with the hardness of another, he made up a scale of hardness. His scale is still widely used today.

Mohs Scale of Hardness

- | | |
|-------------------|-----------------------|
| 1. Talc (softest) | 6. Feldspar |
| 2. Gypsum | 7. Quartz |
| 3. Calcite | 8. Topaz |
| 4. Fluorite | 9. Corundum |
| 5. Apatite | 10. Diamond (hardest) |

The scale of hardness is arranged so that any mineral listed will leave a scratch mark on all the minerals that have lower numbers; and each listed mineral will be scratched by all of the minerals that have a higher number. For example, apatite will scratch fluorite and will be scratched by feldspar. The minerals named in the scale are the examples used by Mohs when he made up his scale.

Classifying Rocks According to Hardness

Investigation 1

Name _____
Date _____
Class _____

Procedure:

- 1) Try to scratch the piece of chalk with your fingernail or thumbnail.
- 2) Does your nail make a scratch mark on the chalk?
- 3) Does the chalk make a mark on the nail?
- 4) Which do you think is harder, the chalk or the nail?

A human fingernail is not very hard. On the Mohs scale, it has a hardness of about 2.5. You know that if you can make a scratch mark on a rock with your fingernail, it is a very soft rock.

- 5) Are there any rocks that are soft enough to leave a mark when you scratch them with your fingernail?
- 6) Complete column one "Rocks That Can Be Scratched By Fingernail" on the worksheet (page 21.)

Classifying Rocks According to Hardness

Worksheet

Name _____
Date _____
Class _____

Rocks That Can Be Scratched By Fingernail	Rocks Scratched By Knife	Rocks Scratched By Glass	Rocks That Scratched Glass

Classifying Rocks According to Hardness

Investigation 2

Name _____
Date _____
Class _____

Procedure:

- 1) Lay the chalk on the table and hold it at one end. Try to scratch the chalk with the knife. Record your observations.

- 2) Try this test on the rocks in your collection. (You don't need to try it with the rocks that you scratched with your fingernail. Why?)

Observe if the knife scratches any of the rocks. A steel knife blade has a hardness of about 5.5 on the Mohs scale.

- 3) Complete column two "Rocks Scratched By Knife" on the worksheet (page 21).

Classifying Rocks According to Hardness

Investigation 3

Name _____
Date _____
Class _____

Procedure:

- 1) Do you think that a steel knife blade will scratch glass? Try it. Record your observations.
- 2) Now take the piece of quartz from the Rock and Mineral Collection. Try to scratch the glass with the quartz.

The knife blade doesn't scratch glass but quartz does. Quartz has a hardness of 7 on the Mohs scale, and the hardness of the steel knife is about 5.5.

So you know that glass has a hardness somewhere between 5.5 and 7.

- 3) If you have any rocks in your collection that were not scratched by the knife blade, they may be scratched by glass. Or some of these rocks may be harder than glass and will scratch it.

Take each of these rocks that you have and try to scratch the glass with the rock.

- 4) Complete column three "Rocks Scratched By Glass" and column four "Rocks That Scratched Glass" on the worksheet (page 21). Record the number of each rock in your collection that was scratched by glass and the number of each rock that scratched the glass.
- 5) In summary, a very soft rock can be scratched by a fingernail. A medium hard rock can be scratched by a steel knife blade, and a hard rock will scratch a piece of glass. Granite (which contains quartz) is about as hard a rock as you will usually find.

The minerals listed on the Mohs scale that have a hardness of 8, 9, and 10 are gem stones. Corundum is a source of both rubies and sapphires. You should not try the scratch test with gems in rings. Although gem stones are hard, they can be chipped or knocked loose from their settings.

Identifying Common Minerals

Science Content: Identifying common minerals

Process: observation, classifying, interpreting data, inference, recording data

Objective: The student will identify mineral specimens with the help of an identification key.

Lesson Outline:

Time: approximately 60 minutes

Materials: Each group of students will need; a set of common mineral samples, a magnet, a streak plate, a hardness kit containing a copper penny, a steel nail, and a piece of glass.

Preparation: Before class sort out various minerals and other materials. You may need to paint small spots or add tape to each mineral sample and number each mineral (if not done previously). Retain a key of your number code for easy reference to mineral type.

Procedure:

1. Review characteristics of minerals. Illustrate with large mineral specimens features including: cleavage, luster, and crystal shape. (Handout Student Worksheet Pages 26 & 27)
2. Introduce the method and procedure of how to use the Mineral Identification Key. If this is the first experience for your students with a key-then you might want to devise a simple activity or demonstration on how the key works. (Handout Mineral Identification Key, p.29)
3. Distribute and show students how to use Data Table 1, p. 30.
4. Break students into small groups (3 or 4 students per group). Distribute materials.
5. Handout student worksheet Page 28, and let the investigation begin. Mention safety precautions concerning nails and glass. Make sure students are using proper techniques, demonstrate proper techniques where necessary.
6. As you circulate around the room, check for understanding by questioning.
7. After the completion of the investigation discuss findings.

Handouts: Student Worksheets and Mineral Identification Key

Extended Activity: Have students collect mineral samples from around their school or home. Then allow them to perform the mineral characteristics tests and see if they can identify each sample. A mineral identification guide would be useful in identifying unknown samples.

Identifying Common Minerals

Background Information:

Scientists have identified more than 2000 different kinds of minerals. However, most minerals are very rare. Over 95% of the earth's crust is made of rocks that are composed of about a dozen minerals. These common minerals are called rock-forming minerals. While minerals can vary a great deal in their chemical makeup and the forms in which they are found, most common minerals can be identified by observing a few of their basic properties. In this investigation, you will observe the physical properties of some common rock-forming minerals and use these properties to identify the minerals. To do so, you will have to test for the physical properties listed below.

Some Physical Properties of Minerals

Hardness: Hardness is the resistance of a mineral to scratching. A mineral will scratch any other substance less than or equal in hardness to itself.

Table of Hardness of Common Items	
Item	Approximate Hardness
Fingernail	2.5
Copper penny	3.5
Steel nail	5.5
Glass	6.0

This means a fingernail will scratch the mineral

In this case, see if the mineral will scratch the glass to avoid students breaking the glass in their hands

Streak: Streak is the color of a fine powder of a mineral. Rubbing a mineral against a piece of dull tile, or streak plate, will powder enough of the mineral to enable you to identify its streak color

Cleavage: Cleavage is the quality of a mineral that causes it to split leaving smooth, flat surfaces. When a mineral does not split to leave smooth, flat surfaces, the break is called a fracture. You can easily observe whether a mineral shows cleavage or fracture.

- Magnetism:** Some minerals are magnetic and will be attracted to a magnet.
- Crystal Shape:** A crystal is a solid that has flat surfaces arranged in a definite shape.
- Luster:** Luster is the way a mineral reflects light. Minerals may be described as having metallic or nonmetallic luster. Metallic luster is the shine associated with a freshly polished metal surface. Nonmetallic luster may be referred to as glassy, brilliant, or greasy.
- Density:** Density, or heft, describes how heavy a sample is for its size. Samples that seem light for their size are described as not being very dense.

Identifying Common Minerals

Name _____
Date _____
Class _____

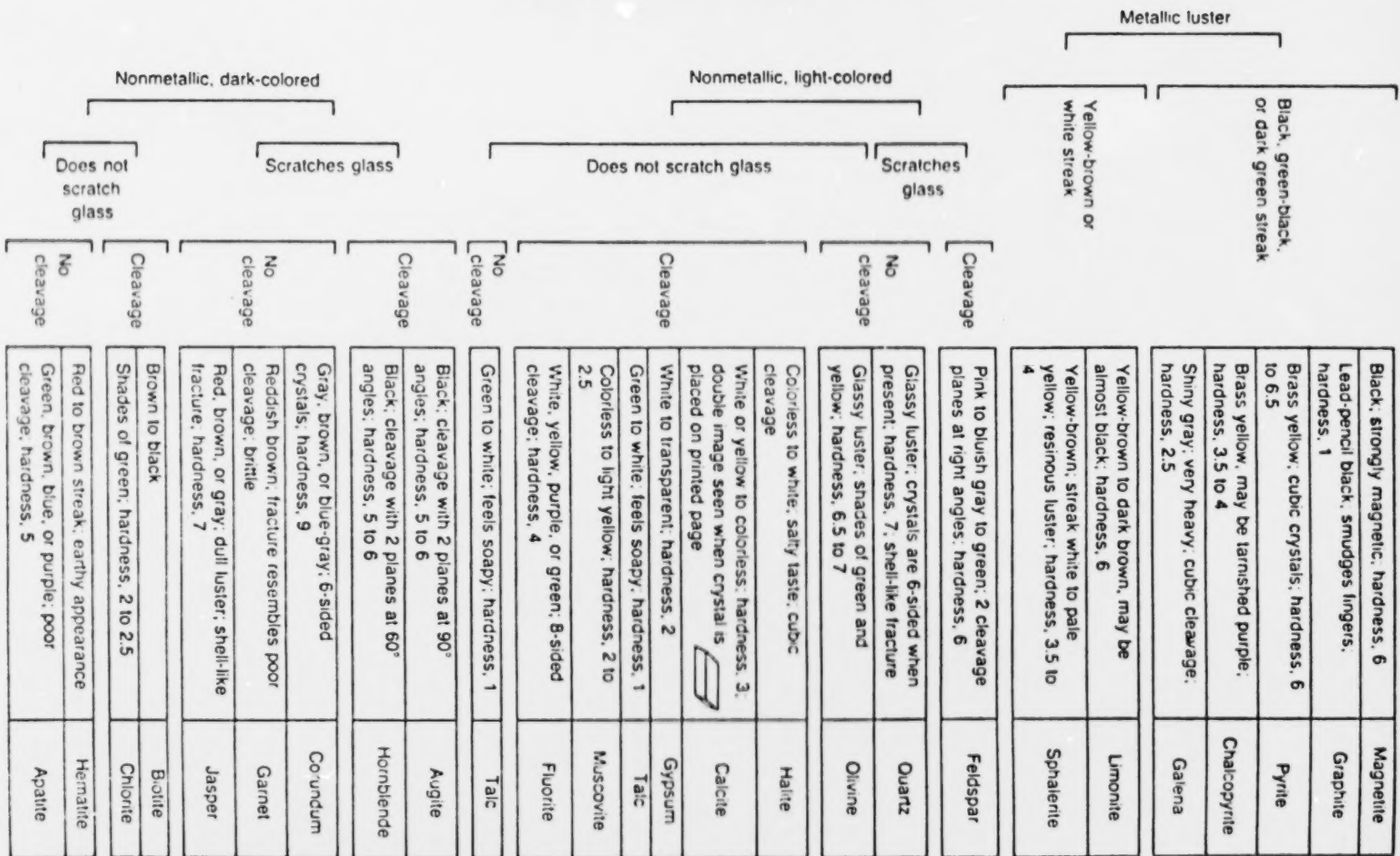
Purpose: To discover how physical properties of minerals can be used to identify them.

Materials: Set of common mineral samples, magnet, streak plate, hardness kit containing a copper penny, a steel nail, and a piece of glass

Procedure:

- 1) Carefully test and observe each of the mineral samples to determine its physical characteristics. Use the summary of minerals' physical properties as your guide. Enter your findings in the appropriate spaces in Data Table 1.
- 2) Using the Mineral Identification Key and the list of your findings, identify each mineral and enter its name in Data Table 1, p. 30.

Mineral Identification Key



Directions: Determine the identity of your samples by comparing their properties with the descriptions listed in the key. Start at the left and work to the right while progressively narrowing the possibilities.

Rock and Mineral Classification

Science Content: Classification (schemes) of rocks and minerals.

Process: observation, classifying, inference, recording data, interpreting data

Objective: The student will develop a classification scheme for the identification of some common rocks and minerals.

Lesson Outline:

Time: approximately 2 periods (60 minutes each period)

Materials: Assorted rock and mineral specimens. (Optional)-Streak plates and Hardness kits.

Preparation: Before class sort out the various rocks and minerals. (Each group of 3 or 4 students should have 10-12 specimens.)

Procedure:

1. Introduction - Discuss characteristics of rocks and minerals.
2. Break students into small groups (3 or 4 students per group).
3. Pending the ability level of the class and the time allocated to the activity (you might want to have students use streak and hardness criteria along with color, shape, luster, cleavage, etc.)
4. Handout student worksheet page 32.
5. Students should be encouraged to proceed in classifying rocks and minerals in their own way. Although there is a model for classification schemes presented for your information (see attached)-it is not necessary that students' schemes fit this model.
6. After the completion of the activity, discuss findings. Tie each aspect of the activity together, checking for students understanding with questioning. Group results should be shared and classification schemes displayed prominently.
7. An explanation of classification schema should follow-highlighting properties of rocks and minerals.

Rock and Mineral Classification

Name _____
Date _____
Class _____

Purpose: To discover ways to classify rocks and minerals according to the specimen's physical characteristics.

Materials: Assorted rock and mineral specimens.

Procedure:

- 1) Pick a specimen. Describe it in detail. Write down everything you can about the specimen.

- 2) Discuss your findings with your group.
- 3) Take all of the specimens and observe each carefully.
- 4) Divide the specimens into two groups. Why did you divide them this way?

- 5) Take the 2 piles and divide each pile into 2 more piles (total piles = 4). Why did you divide them the way that you did?

- 6) Keep breaking the piles down until you have only one or two specimens left in a pile. Remember to write down reasons for each division.

- 7) On a separate sheet of paper, take your reasons and make a chart that through descriptions and pictures shows how your group split the specimens.